



The Solutions Network

Rochester, New York

Setting the Bar: Establishing An Energy Baseline

Phil Voss

National Renewable Energy Laboratory

1

What is the baseline and why is it important?



- The baseline energy use is the amount of energy the facility (or specific equipment) uses prior to retrofits
- Documenting the baseline is imperative in ESPC, because once retrofits are installed, the baseline no longer exists
- Baseline is the starting point for determining energy savings, and the foundation of the M&V plan

When is the baseline determined?



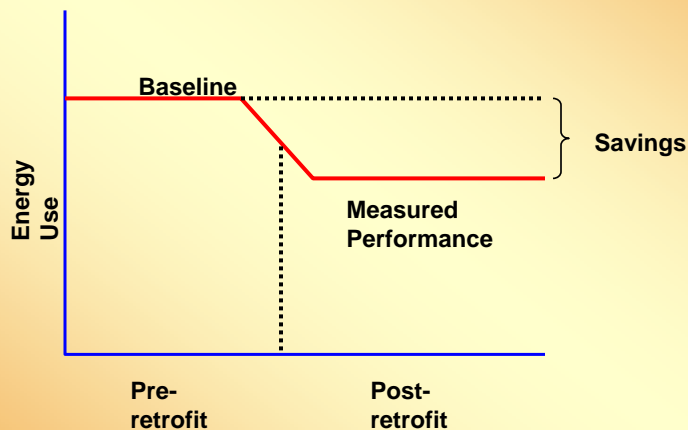
- The plan for developing the baseline should be established in the initial proposal
 - Agreed upon before the DES
- Baseline is established during the DES
 - Agreed upon before signing the Delivery Order

The DES is your LAST CHANCE to establish the baseline conditions!

www.energy2004.ee.doe.gov

3

Determining savings from energy conservation retrofit projects



www.energy2004.ee.doe.gov

4

Agency Role in Baseline Development



- Provide facility/equipment access and information to the ESCO
- Review, discuss, and come to agreement on baseline methodology
 - Stipulated and measured parameters
 - Metering to be performed and duration
- Witness metering activities
- Review data and baseline for reasonableness and accuracy

www.energy2004.ee.doe.gov

5

Establishing the Baseline



- ESCO audits facility and documents equipment, rated capacities and efficiencies, energy use factors, loads, etc.
- ESCO and agency select equipment/systems for potential replacement
- ESCO and agency agree on approach to determining baseline energy use

www.energy2004.ee.doe.gov

6

FEMP M&V Options

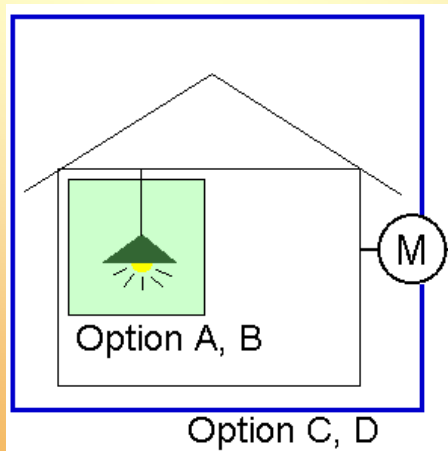


M&V Option	How savings are calculated
Option A: Based on <i>measured</i> equipment performance, measured or <i>stipulated</i> operational factors, and annual verification of ' <i>potential to perform</i> '	Engineering calculations
Option B: Based on <i>periodic or continuous measurements</i> taken throughout the term of the contract at the device or system level	Engineering calculations using measured data
Option C: Based on <i>whole-building</i> or facility level utility meter or sub-metered data adjusted for weather and/or other factors	Analysis of utility meter data
Option D: Based on <i>computer simulation</i> of building or process; simulation is calibrated with measured data	Comparing different models

www.energy2004.ee.doe.gov

7

Approaches to Baseline



Options A&B are retrofit isolation methods

Options C&D are whole-building (or whole-facility) methods

The difference is where the boundary lines are drawn

www.energy2004.ee.doe.gov

8

Option A



- Simple approach (and low cost)
- Performance parameters are measured (before & after), usage parameters are often *stipulated*
- Used where the '*potential to perform*' needs to be verified but accurate savings estimation is not necessary
- ***Option A is NOT 'stipulated savings'!***

www.energy2004.ee.doe.gov

9

Stipulation Defined



- To stipulate is to agree to a term or condition
- Under FEMP, to stipulate means to *estimate without measurement*
- A parameter is either *measured* or *stipulated*, but not both
- A measured parameter can be fixed for the contract term
 - For example, baseline operating hours of a system or building

www.energy2004.ee.doe.gov

10

Option A Applications



- Projects where performance remains constant and usage can be readily characterized
 - Lighting efficiency
 - Timeclock controls
 - Efficient motors
 - Operations & Maintenance
- For proper use, refer to: "Detailed Guidelines for FEMP M&V Option A", May 29, 2002

Lighting: Option A (LE-A-02)



- ESCO proposes LE-A-02: Measured fixture power
- Power measured once on a sample of common existing fixture types before and after retrofit
- Facility operating hours stipulated based on schedules for each usage group (office, exam, patient room...)
 - How schedule is determined is very important!
- Heating & cooling load interactions stipulated based on engineering calculations

Lighting LE-A-02 Baseline/M&V Comments



- Measuring fixture power pre- and post-retrofit provides more reliable baseline and savings estimates than using lighting wattage tables
- Agency accepts usage risk by using estimated operating hours
 - Uncertainty and risk can be reduced by measuring operating hours during DES, but this comes at a cost
- Interactive heating & cooling effects estimated using the method of Rundquist

Rundquist, "Calculating Lighting and HVAC Interactions,"
ASHRAE Journal 35, no. 11 (1993).

www.energy2004.ee.doe.gov

13

Option B



- Under Option B, some or all parameters are measured periodically (spot or short-term) or continuously
- Applicable where accurate baseline and savings estimation is necessary and where long-term performance needs to be tracked
- Reduced uncertainty, but requires more time and effort

www.energy2004.ee.doe.gov

14

Option B Applications



- Projects with large elements of uncertainty and/or risk (\$\$\$)
 - Variable speed drives
 - Chillers and chiller plants
 - Energy management & control systems
 - Projects where equipment needs constant attention
- Spot or short-term metering can be used for low operational variations
- Longer-term metering may be more appropriate for high variability

Using Option B for Baseline



- ESCO measures system input energy and demand for agreed-upon duration
 - Duration should account for full range of system operation
- System output and some independent variables (temperature, set-points, occupancy) will also be monitored

VAV: Option B (GVL-B-01)



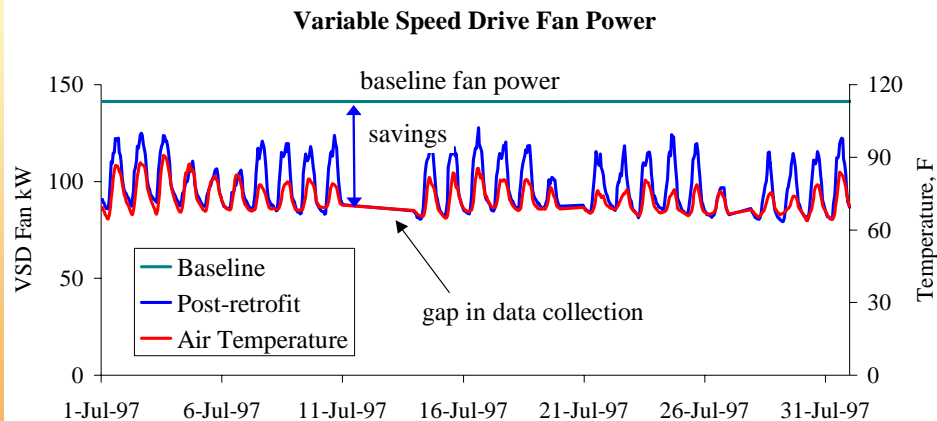
- Parameters measured (1x) during DES (baseline)
 - Air flow
 - Fan power
 - Fan schedule
- Parameters monitored (continuously) w/EMCS (post-retrofit)
 - Fan power
 - Fan speed (proxy for air flow)
 - Fan schedule

VAV: Option B (cont'd.)



- Fan energy savings based on difference between baseline power and monitored power
- Heating and cooling savings based on airflow reductions at post-retrofit operating temperatures to prevent double-counting savings from EMCS measure
- Using EMCS for monitoring reduces M&V equipment cost

VAV: Monitor Fan Performance



www.energy2004.ee.doe.gov

19

Conclusions



- Accurate baseline definition is critical
- Agency highly involved in baseline determination
- Options A & B can be used effectively to define the baseline of specific systems
 - Isolates the system energy use from the rest of the building or facility
 - Option A better for low operational variability; Option B better when variability is higher and more accuracy is needed
- When systems are highly interactive or potential energy savings for the *building* is very large, Option C or D may be more appropriate

www.energy2004.ee.doe.gov

20